RESEARCH DEPARTMENT

THE DESIGN OF THE LIP MICROPHONE
TYPE L2

Report No. M.022

Serial No. 1954/29

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SUMMARY.

A new lip microphone of the "noise-cancelling" type has been developed, having properties basically similar to those of the type L1 but incorporating a number of improvements. The problems peculiar to this type of instrument are analysed and the construction, performance and special features of the new design are described. A large number of production models has given satisfactory service for some time.

1. INTRODUCTION.

This report describes the new commentators' lip microphone, type L2, which was developed in Research Department in 1950. Ninety-six of these are now in service.

The function of this microphone is similar to that of the type L1. It is used in noisy surroundings to transmit a much higher ratio of signal to ambient noise than is possible with other types of microphone. It will be assumed in the report that the reader is familiar with the description of the type L1 given in Technical Instructions ST 5, but as the type L1 has not been the subject of a Research Report, the problems peculiar to this class of microphone, as well as a number of constructional features common to both designs, will be discussed in some detail.

2. HISTORICAL.

Commentaries are often required from noisy surroundings such as exist at football matches, races and operas. It is desirable that the ratio of speech to ambient noise level reproduced by the listener's loudspeaker should be considerably greater than that existing at the point of origin. The difficulty of achieving a high signal-to-noise ratio is increased, for example, at an opera house or concert hall, because it may be necessary to use a subdued voice. In the early days of broadcasting, it was often necessary to house the commentator in a sound-proof booth, an inconvenient expedient giving poor quality owing to the effects of reverberation in the confined space. In 1937, the position was radically altered by the development, in Research Department, of a close-talking pressure-gradient ribbon microphone

of the so-called noise-cancelling type, which eventually became known as the lip microphone type L1*. This microphone gave sufficient discrimination between direct and ambient sound without a booth, and the quality of speech attained, whilst inferior to that of the studio ribbon microphones of the period, was better than that from the contemporary moving-coil Outside Broadcast (O.B.) microphones.

The type L1 microphone, whilst not the first noise-cancelling instrument (telephone transmitters working on the same principle had been patented by Siemens and Halske in November 1936) was probably the first microphone of that kind giving speech quality good enough for broadcast transmissions and was certainly the first to be used for this purpose.

Towards the end of the war, the possibility of improving on the original design of the L1 microphone was considered by Research Department in conjunction with O.B. and Recording Departments. O.B. Department decided to retain the original model with only trivial modifications. It appeared however that for recording purposes certain of the requirements laid down for O.B.'s could be relaxed; a smaller, lighter and simpler construction thus became possible and a supplementary design on these lines was accordingly requested. Work on this was commenced by Research Department in 1946, but was suspended until 1949 in favour of more urgent commitments. Prototypes were put into experimental service in 1950 and 1951, the design was approved by the Designs Co-Ordination Committee in November 1951 and production models were used for the Coronation broadcasts in 1953.

Although the type L2 microphone was originally intended for recording purposes only, and does not embody all the mechanical features once deemed necessary for O.B. work in general, the characteristics are in many respects an improvement on that of the type L1, and the new model will probably come into general use.

There is still no other known microphone comparable in performance to the type L1 or L2 available in any country. The frequency-response of "noise-cancelling" microphones in general is very poor and the only design[1] for which serious claims of high quality are made, is larger, has no means of location with respect to the user's mouth and has disadvantages on both acoustic and hygenic grounds. The lack of any means of location is serious, as the distance of the microphone from the source of sound affects the frequency response and noise suppression properties, and must therefore be closely controlled.

3. GENERAL.

3.1. Aims of Design.

The type L2 design was intended to be an improvement on the original type L1 in the following respects:

a. Weight and size.

b. Sensitivity.

c. Frequency characteristics.

*It should be noted that in present-day usage, the description "lip microphone" is not confined to instruments of the "noise-cancelling" type but may be applied to any microphone intended to operate at a very short (usually fixed) distance from the speaker's mouth.

As the design progressed additional requirements were added:

d. Reduction of magnetic induction pick-up.

e. Reduction of breath noise.

3.2. Principle of Operation.

The principle of operation of the types L1 and L2 is the same and is described in the Technical Instructions ST 5, Part 2. Both are pressure-gradient ribbon microphones, and the reduction in ambient noise pick-up is obtained largely by means of the rise in particle velocity due to proximity of the sound source. Added discrimination against ambient noise is given by the figure-of-eight polar characteristic and by a shadowing effect of the user's head.

3.3. General Description.

The general appearance and dimensions of the microphone are shown in Figs. 1, 2 and 3. The case is made of perforated brass lined with a very fine metal gauze. The microphone is held at a fixed distance from the mouth by means of the curved mouthguard, which is kept lightly in contact with the speaker's upper lip; the lower part of the mouthguard is cut away to allow the bottom lip to move freely. A screen S, of stainless steel gauze, is attached to the front and another to the top of the case to reduce the effects of breath noises and of condensation inside the microphone.

The U-shaped magnet structure is housed in the upper portion and the ribbon lies in a vertical plane, its longitudinal axis being horizontal. The yoke of the magnet is between the ribbon and the user's mouth.

The spring suspension of the magnet system in the type L1 microphone is replaced in the type L2 by soft rubber. With this arrangement there is no risk of damage through vibration in transit and no clamping mechanism is therefore necessary.

The ribbon is connected by a balanced wiring circuit to the magnetically screened ribbon-to-line transformer in the handle, and the output is taken from the transformer terminals by a lead held in a flexible sleeve. For convenience in holding, the handle has an oval cross-section and its angle with respect to the microphone head can be adjusted in a vertical plane.

3.3.1. Weight.

The weight of the microphone without its cable is 1·0 lb (0·45 Kg), little more than half the weight of the type L1. The difference of 0·8 lb (0·36 Kg) is mainly due to the elimination of the spring suspension system and the travelling clamp used in the type L1, and to the reduction in the size of the case made possible by these changes. A small additional reduction in the weight of the L2 could have been achieved by making the case and mouthguard of a light alloy, but would not warrant the extra cost due to manufacturing difficulties.

3.3.2. Output.

The output of the type L2 microphone is 5 dB higher than that of the type L1. Of this difference, 4 dB is obtained by the use of modern magnetic material and 1 dB by reduction in the distance between the ribbon and the speaker's mouth.

4. DESIGN DETAILS.

4.1. General.

In the following paragraphs various parts of the type L2 microphone are described in detail. Reference should be made to Fig. 1 which shows the type L2 complete and to Figs. 2 and 3 which show the microphone partially dismantled.

4.2. Ribbon.

The ribbon, as in the type L1, is made of aluminium leaf weighing 3×10^{-6} lb/in.^{2} (0·2 mg/cm^2) and has an average thickness of $2{\cdot}5 \times 10^{-5}$ in. (0·6 micron); the width is 0·10 in. (0·25 cm) and the ribbon is corrugated along its 1·0 in. (2·54 cm) length. The gap between the edges of the ribbon and the pole pieces is 0·012 in. (0·030 cm), this value being a compromise between two conflicting factors. A large gap would effectively shunt the acoustic resistances which control the ribbon motion at low frequencies, whilst a very small gap is undesirable for operational reasons. The tension is adjusted to give a fundamental resonance frequency between 40 c/s and 60 c/s with the ribbon open-circuited and undamped.

Although it is not critical, there is an optimum distance of the ribbon from the mouth, for whilst bringing the microphone closer to the sound source increases the discrimination against random noise, the problem of breath noise also becomes greater and in addition care must be taken that the null in the figure-of-eight polar response does not discriminate excessively against nasal sounds. For example, if the ribbon were situated at the front of the microphone instead of at the back, nasal sounds would be largely suppressed; if, to avoid this effect, the unit were tilted, the sensitivity to direct signal from the mouth would be reduced.

As a compromise between these factors the ribbon in the type L2 microphone is positioned at a distance of $2\frac{1}{8}$ in. (5·4 cm) from the mouth, i.e. $\frac{3}{8}$ in. (1 cm) less than that in the L1. The curved portion of the magnet shown in Figs. 2 and 3 is towards, and the ribbon away from, the user's mouth. The magnet thus helps to protect the ribbon from breath.

As in the type L1 the large increase in bass response caused by the proximity of a sound source is equalised by two series acoustic resistances marked R in Fig. 3. In the type L2 microphone the resistances are made of silk bolting cloth, this material being manufactured to a specified mesh and therefore more uniform than ordinary cloth weaves. One resistance is in front of and another behind the ribbon. There is a considerable advantage in obtaining the necessary low-frequency attenuation by the addition of acoustic impedances rather than by electrical equalisation, as the construction then allows the microphone to be used in winds of considerable velocity

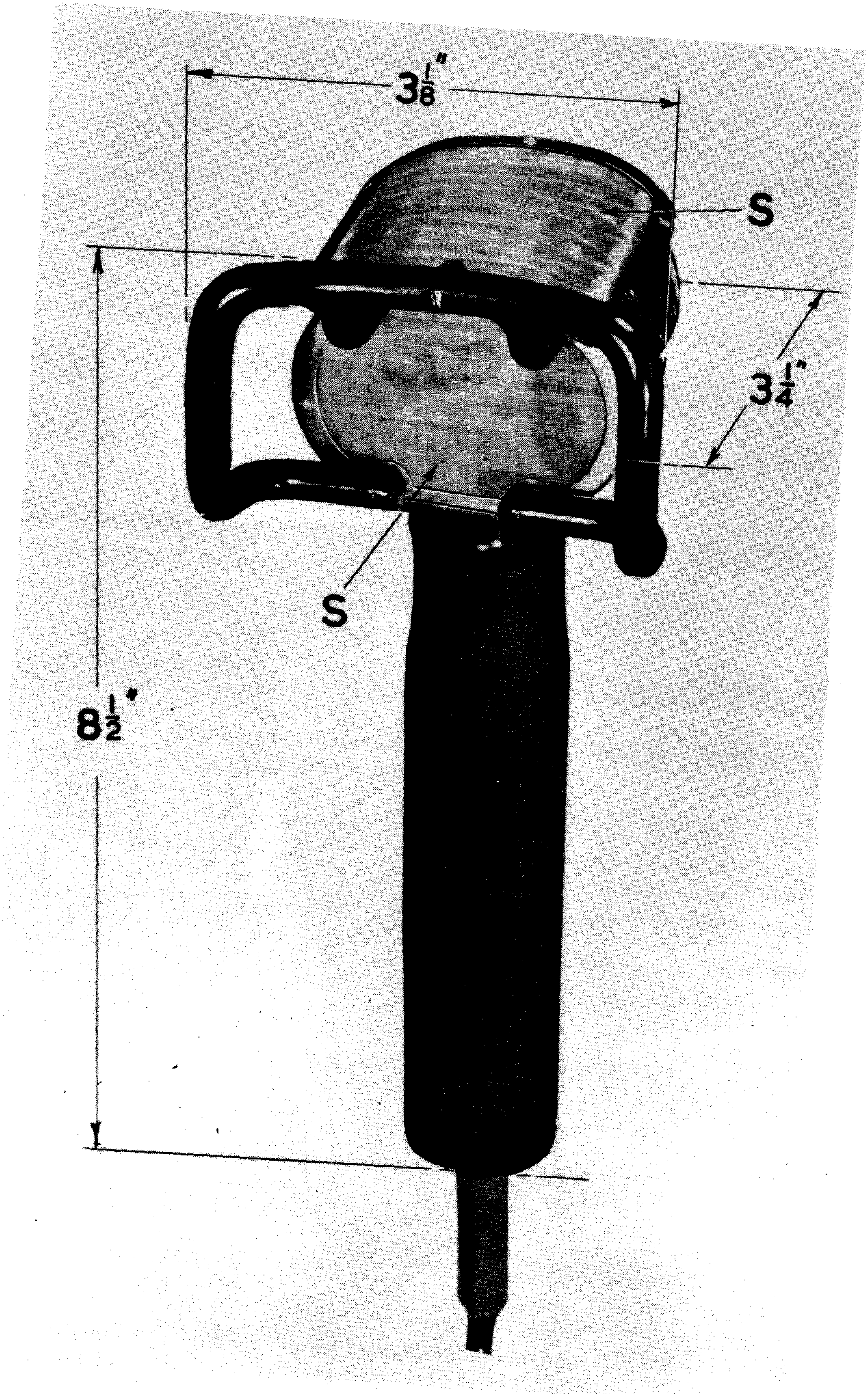

Fig. 1

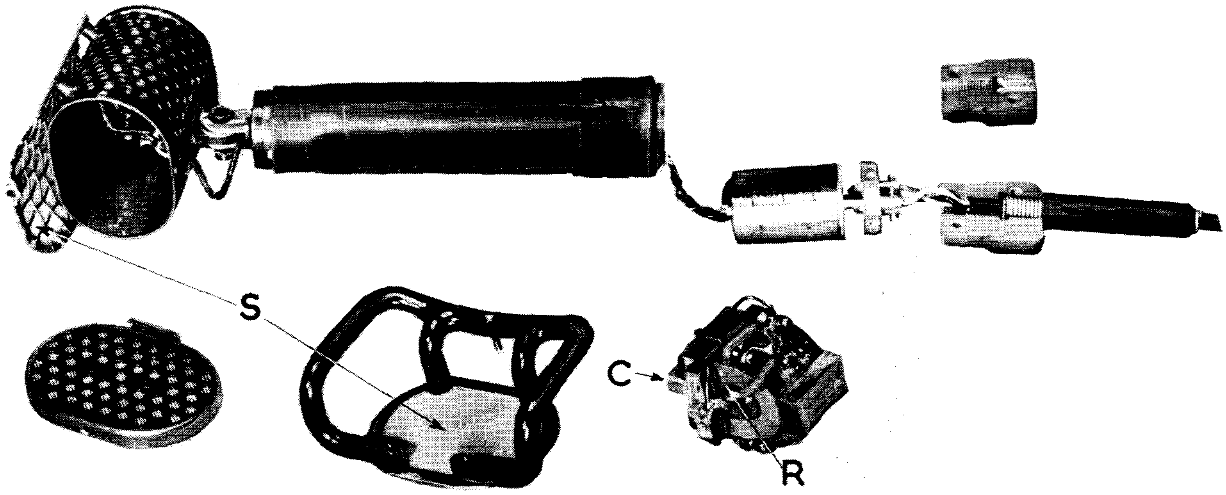

Fig. 2 - Exploded view

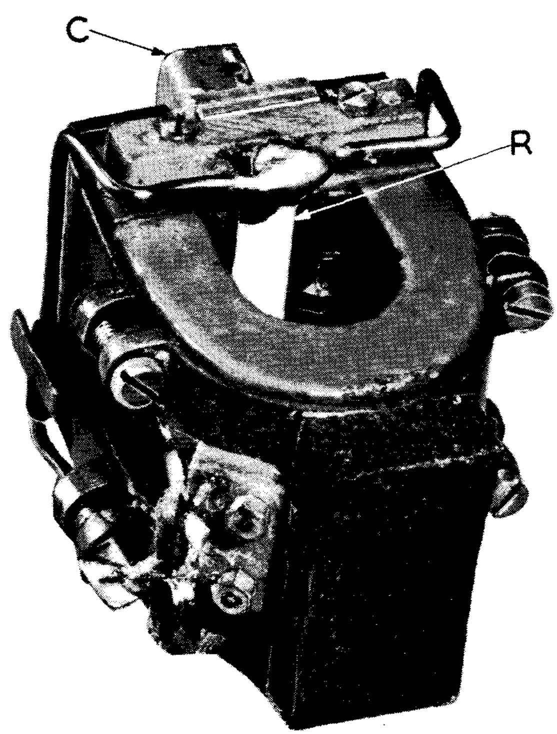

Fig. 3 - Magnetic system

without fear of rumble, and in winds of at least 40 m.p.h. (64 Km.p.h.) without damage.

4.3. Low-Impedance Wiring.

The type L1 microphone, as originally designed, was subject to magnetic induction interference when used close to television monitors, which have a high stray magnetic field from the mains transformer and line scanning coils. Some of these microphones were modified as described in Research Department Technical Memorandum No. M.1009 and an improvement in signal to magnetic induction ratio of 35 dB was obtained. The experience thus gained was applied to the design of the L2 and the low-impedance wiring from the ribbon to the output transformer was magnetically balanced.

Owing to the elimination, in the type L2, of mounting springs, the balanced wiring can be of a simpler shape than in the modified type L1, resulting in a smaller loop area, with the advantage that the magnetic balance is not so seriously upset when the interfering field is non-uniform. This is important in the case cited above where the field is so non-uniform that the pick-up in the type L1 is about 6 dB more than that obtained in a uniform field of the same average strength.

4.4. Magnetic System.

The U-shaped magnet is made of Ticonal G and is similar in mechanical design to that of the type L1 with the exception of differences in detail necessitated by the fact that Ticonal is too brittle to be drilled and tapped. The pole pieces are of mild steel as the flux density of approximately 2000 gauss is not high enough to warrant the use of a special material.

The complete magnetic system is held in position by rubber-covered pillars at the back, and by a pad of sponge rubber at the front. In both models the sides of the magnet have openings to reduce the path length from the front to the back of the ribbon, but at about 5 kc/s the volume of air enclosed by the magnet resonates with the mass of the air in the openings. In these circumstances an increased pressure is produced on the magnet side of the ribbon and the difference in phase between the sound pressure on either side of the ribbon is also upset. Thus not only is an excessive rise in response produced, but the natural cut-off frequency is lowered, with a corresponding degradation of signal quality.

In the L2 therefore, the cavity marked C in Fig. 3 has been built on the opposite side of the ribbon to re-establish the correct phase relationship between the two sides, thus reducing the rise in response and extending the frequency range. This feature contributes materially to the improved frequency characteristics of the type L2 over the type L1 and is further considered in section 5.1.2. The use of a cavity for this purpose is covered by B.B.C. Patent Application No. 24513/52.

4.5. Case.

The upper case is made of 22 SWG perforated brass, the perforations covering approximately 50% of the area. It is lined inside with phosphor bronze wire gauze of

44 SWG and 125 meshes per inch (49 per cm). To avoid discomfort in cold weather the mouthguard is covered with a layer 0·02 in. (0.05 cm) thick of a plastic material.

The handle houses the magnetically screened ribbon-to-line transformer. After tests with two prototypes having different lengths of handle, the service departments chose a length of $5\frac{3}{4}$ in. (14·6 cm). For comfort over long periods the handle is of oval cross section with the minor axis running from the front to back of the microphone. At the request of the operating departments the angle of tilt of the handle with respect to the microphone head is made adjustable to suit individual requirements.

4.6. Breath Shields.

Screens, marked S, are extended over the top and the front of the microphone to reduce the effects of breath noises and of condensation.

The problem of suppressing breath noises becomes very difficult at the distances at which lip microphones are used. There are two main types of unwanted breath noises; one is the sound of breath impinging on the microphone case, whilst the other is due to the pulse of breath used in enunciating explosive consonants. The magnitude of the latter effect may be illustrated by comparing the wanted and unwanted components of air velocity. At $2\frac{1}{8}$ in. from the mouth, the sound pressure due to speech is about 20 dyne/cm^2 and the maximum likely value of particle velocity, obtained by assuming the whole of the sound energy to be concentrated at a frequency of, say, 100 c/s, is of the order of 50 cm/sec. In contrast to this figure, the velocity of the breath expelled in pronouncing the consonant "p" is of the order of 1000 cm/sec. It is clear that to avoid an exaggerated effect the ratio of the corresponding signals in the microphone output must be very much reduced. Past methods of achieving this have had some success, but are usually accompanied by deterioration in frequency response or in noise-suppression properties. In the type L2 the method used, which is also covered by the patent already mentioned, is as follows: The case of the microphone is covered with a closely-woven gauze. The acoustic impedance of this gauze is made as high as is consistent with the avoidance of excessive internal reflections or distortion of the wave front, on the shape of which the noise-suppression properties of the microphone largely depend. Outside, and spaced away from the case, is a baffle of similar gauze. The space between the baffle and the case is open to the air and acts as a low-impedance shunt between the two gauze impedances. In this way, for the same attenuation of breath noises, a more open mesh gauze can be used than would otherwise be possible, and no deterioration is produced in either the frequency response or the noise-suppression properties of the microphone.

The screens used are of stainless steel gauze 40 SWG 90 meshes per inch (35 per cm) the top screen being supported by brass gauze 20 SWG 4 meshes per inch (1·6 per cm). The top screen is $\frac{3}{16}$ in. (0·48 cm) from the case whilst that at the front is approximately $\frac{1}{8}$ in. (0·32 cm).

4.7. Output Connections.

Output connections are made to miniature terminals on the ribbon-to-line

transformer. The output cable passes through a flexible sleeve to prevent the leads from being sharply bent, with the possibility of eventual fracture, at the point of exit. The leads are connected to the terminals of a standard equaliser box, as used in the type L1.

5. PERFORMANCE.

5.1. Frequency Response Characteristics.

5.1.1. Methods of Measurement.

Frequency characteristics above 200 c/s were measured by comparison with a pressure standard in a dead room, corrections being calculated where necessary for the effect of the slight curvature of the wave front. Measurements below 200 c/s were made in a travelling-wave duct. Some of the curves relate to an early experimental model of the type L2 microphone and were taken before the plane-wave duct was available; these are subject to additional errors up to ± 1 dB at low frequencies due to standing wave effects and uncertainty as to the effective position of the source. The calibration of the pressure standard is known to $\pm\frac{1}{2}$ dB and the comparison is also accurate to $\pm\frac{1}{2}$ dB.

Approximate frequency characteristics for the wanted speech have been calculated by assuming the sound to come from a fixed point source. In fact, the effective distance of the source from the microphone[2] varies from one speech sound to another over a range of $\pm\frac{1}{2}$ in. (± 1·3 cm).

Some of the measurements, particularly those concerning the effect of the breath shields on the shape of the wave front, required to be made with the microphone in close proximity to a point source and an artificial head, shown in Fig. 4, was therefore used. Under these conditions, the effect of ambient sound is small and the tests can be carried out in a live room; further, the detail in the response curves at the lower frequencies can be more easily delineated. In order that the microphone response to sounds from the direction of the mouth and nose may be individually evaluated, two separate sound sources, appropriately located in the artificial head, are used. To reduce the effect of the acoustic obstacle presented by the microphone, both the sources are designed to have a high internal acoustic impedance. It is not yet known to what degree of accuracy the measurements of the response on the artificial head represent the characteristics of the microphone, but the correlation with the axial free-field measurement is generally good when theoretical corrections for the distance of the source are applied. As far as is known, no previous attempts have been made to measure the response of this kind of microphone to sounds from the nose, but the importance of this response was forcibly demonstrated during the design of the upper breathguard, when it was found that the response to sounds from the direction of the nose could be suppressed without affecting the response to sounds from the direction of the mouth.

5.1.2. Frequency Characteristics.

Figs. 5, 6, 7 and 8 show the axial frequency characteristics of a type L2

Fig. 4 - Artificial head with separate sound sources for mouth and nose

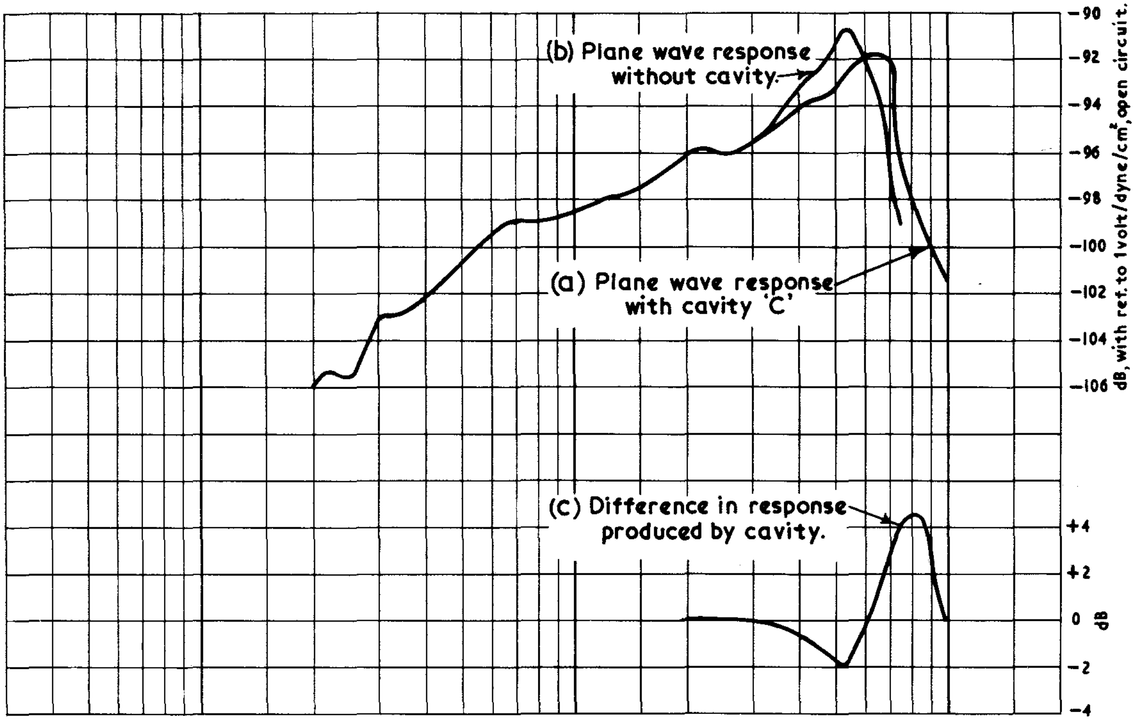

Fig. 5 - Frequency response of experimental L2 microphone. Equaliser set at "medium bass"

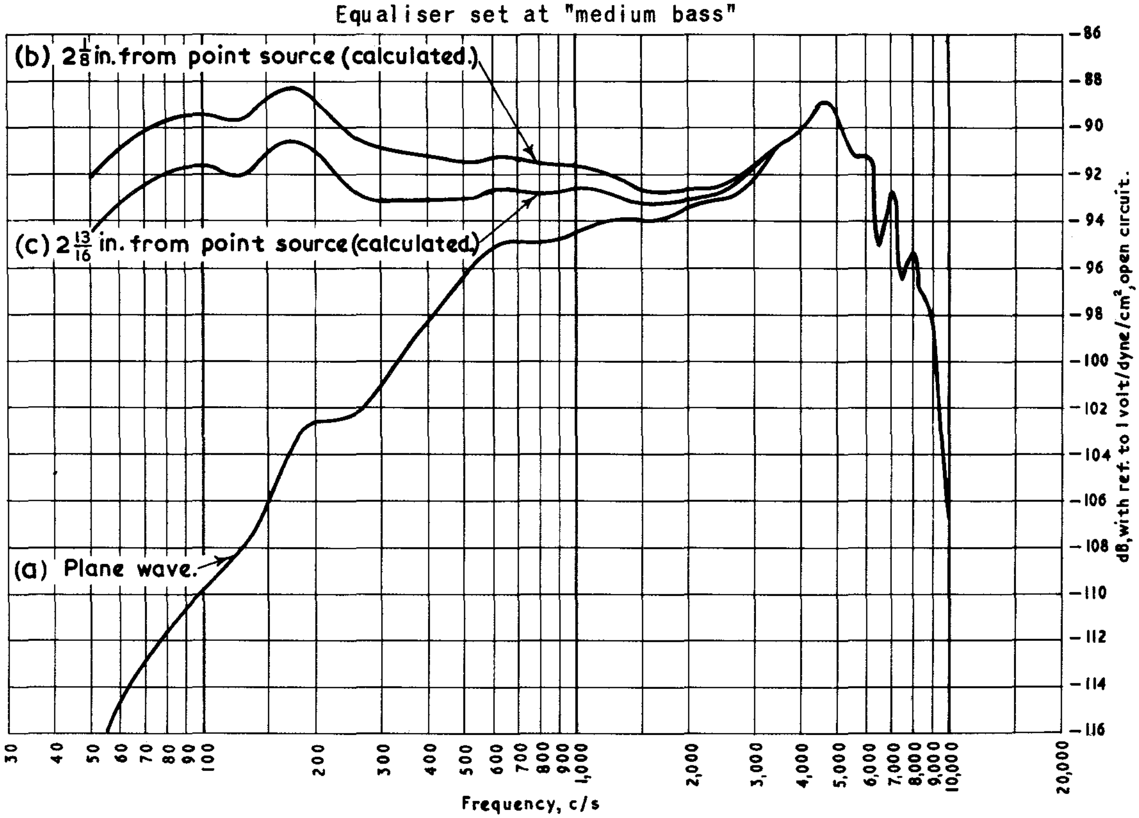

Fig. 6 - Frequency response of prototype L2 microphone. Equaliser set at "medium bass"

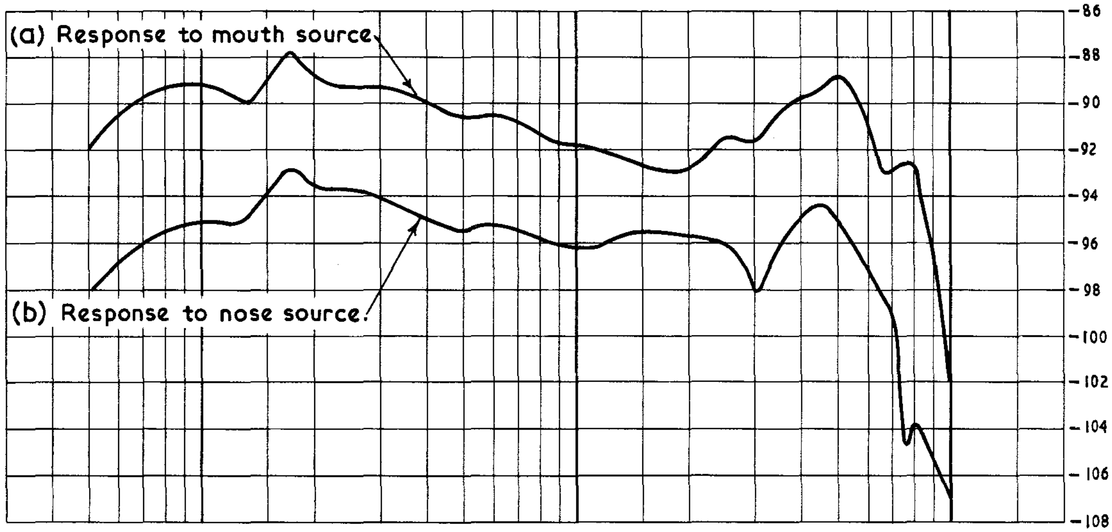

Fig. 7 - Frequency response of prototype L2 microphone measured on artificial head. Equaliser set at "medium bass"

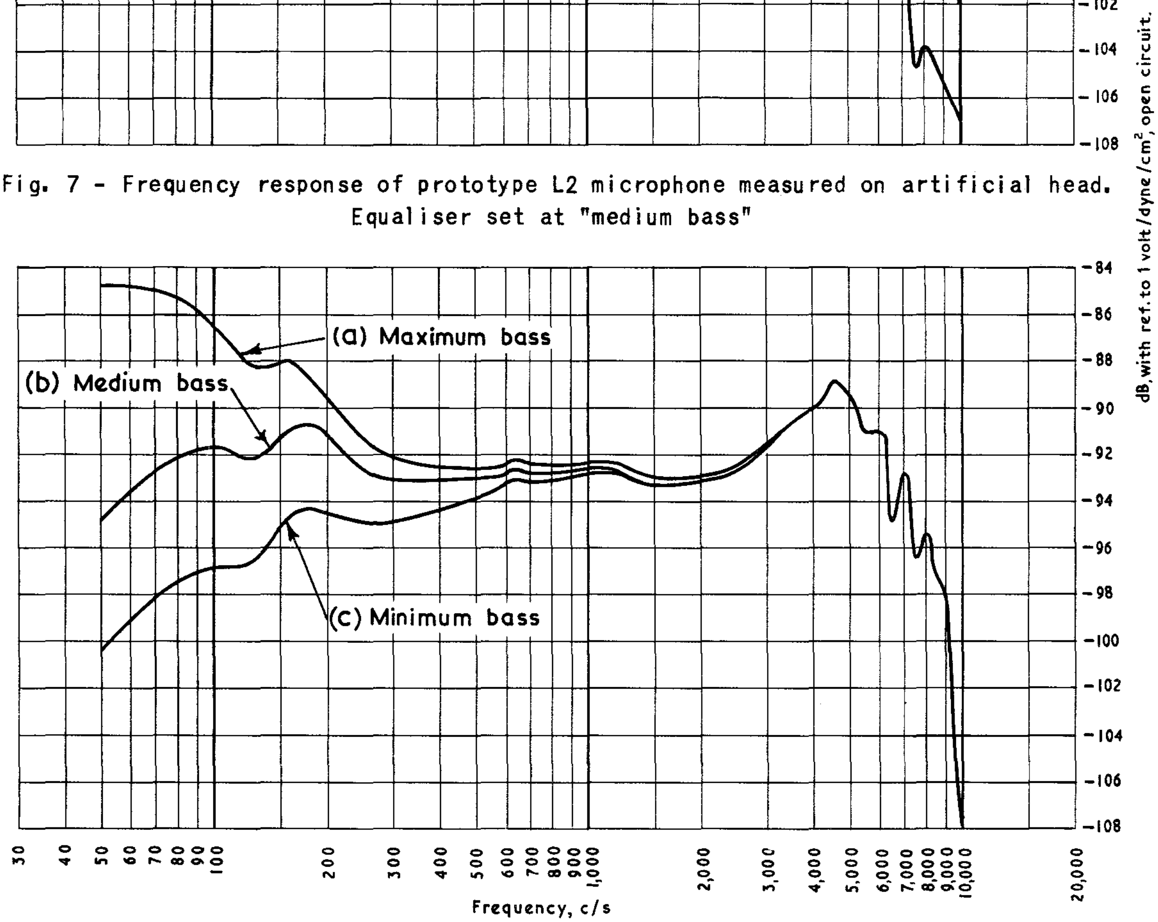

Fig. 8 - Frequency response of prototype L2 microphone $2\frac{13}{16}$ in. from point source (calculated). Equaliser set as shown

microphone. Figs. 6, 7 and 8 relate to a prototype model while the curves of Fig. 5, which show the effect of the cavity C of Fig. 3, were taken with an earlier experimental microphone having an old type magnet of cobalt steel. Figs. 9 and 10 show, for comparison, the corresponding characteristics of the type L1.

The type L2 microphone, like the type L1, is normally used with a three-position equaliser to compensate for the difference in character of the commentator's voice for different levels of speech. Position No. 3 gives the unequalised response, whilst positions Nos. 2 and 1 give different degrees of bass cut; these positions are intended for loud, average and quiet speech respectively. Except where otherwise stated the response curves apply to the microphone with the equaliser in position No. 2.

Fig. 5(a) shows the axial plane-wave frequency response of the experimental L2 for sound incident from the front. For comparison the corresponding curve without the rectangular cavity C mentioned in section 4.4. is shown in Fig. 5(b), and the effect of the cavity, i.e. the difference between curves 5(a) and 5(b), in Fig. 5(c).

Figs. 6(a) and 9(a) give the axial response to a plane-wave of the prototype L2 and of a type L1 respectively, whilst Figs. 6(b) and 9(b) give the axial response to a point source at distances of $2\frac{1}{8}$ in. and $2\frac{1}{2}$ in. Figs. 7(a), 7(b), 10(a) and 10(b) give the characteristics of the respective microphones when using the mouth and the nose of the artificial head as separate sources. Figs. 8(a), 8(b) and 8(c) show the calculated response of the L2 microphone to a point source $2\frac{13}{16}$ in. (7·2 cm) from the microphone for the three positions of the equaliser. In this figure, for reasons which are discussed later, the distance of the microphone from the sound source has been taken as $2\frac{13}{16}$ in. instead of $2\frac{1}{8}$ in.

For the purpose of the calculations for Figs. 6(b) and 9(b) the sound was assumed to come from a point in the region of the lips. At distances large compared with the dimensions of the mouth opening this is a reasonable assumption but at smaller distances more precise information is desirable. Whilst it is not possible to assign a unique position to the apparent sound source, it is of interest to examine the results of applying published data. It has been shown[2] that this source may lie between 0·05 in. (0·13 cm) and 1·1 in. (2·8 cm) behind the lips. To some extent however the position varies with the sound spectrum, the higher frequency sounds usually originating nearer the lips. It is at low frequencies that the microphone output is most affected by changes in the position of the source, and a fair estimate of the frequency response can be made by averaging the distance of the source behind the lips for frequencies below 500 c/s. The figure of $\frac{11}{16}$ in. (1·7 cm) thus obtained is equivalent to $2\frac{13}{16}$ in. from the ribbon in the type L2 microphone and $3\frac{3}{16}$ in. (8·1 cm) in the type L1. Figs. 6(c) and 9(c) show the frequency response of the microphones calculated on this basis.

5.2. Impedance.

The nominal impedance of the type L2 microphone alone is 250 ohms and of the microphone with equaliser, 300 ohms. The measured impedance of one specimen is given in Fig. 11 for the three positions of the equaliser, from which it will be noted that the impedance is substantially constant over the audio-frequency band. The frequency characteristic into 300 ohms is therefore essentially the same as that into an open circuit.

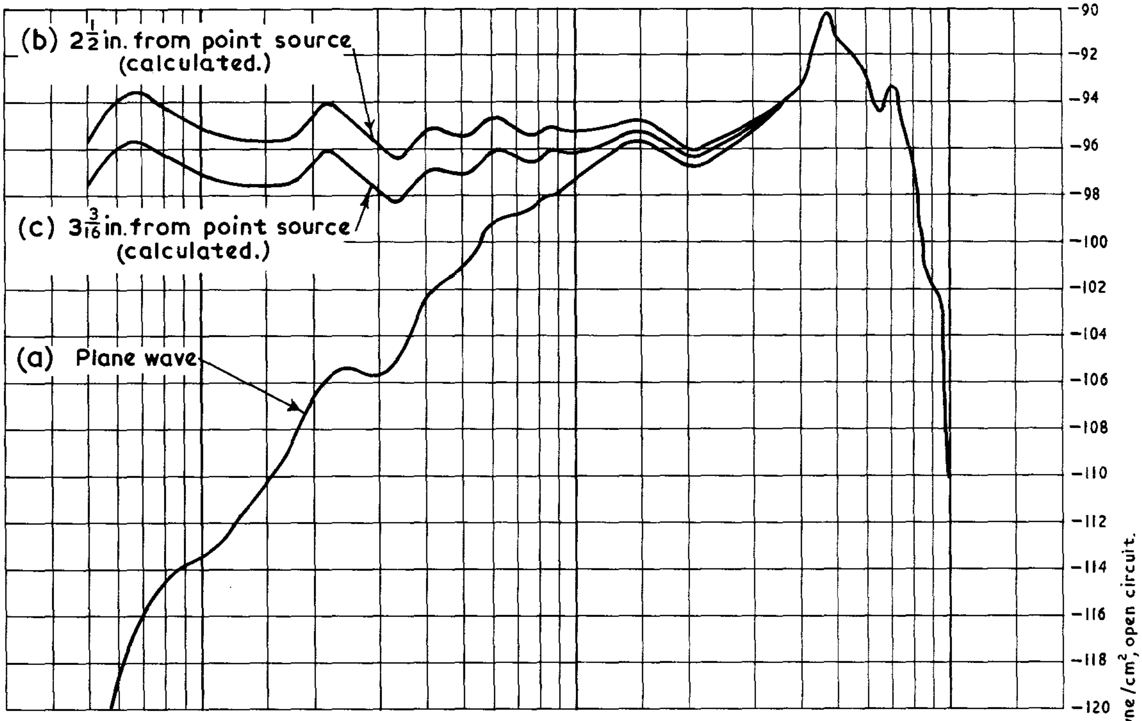

Fig. 9 - Frequency response of type L1 microphone.
Equaliser set at "medium bass"

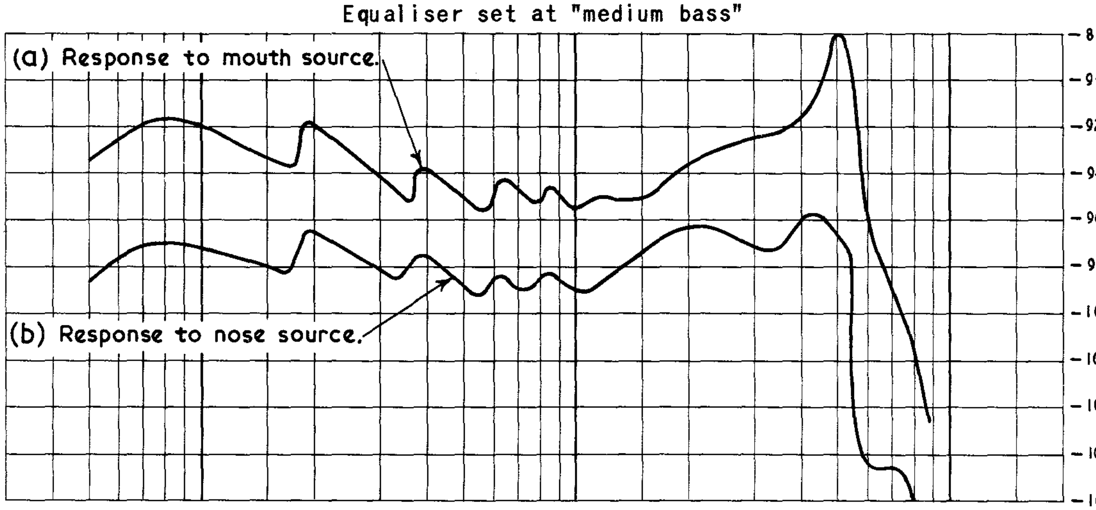

Fig. 10 - Frequency response of type L1 microphone on artificial head.
Equaliser set at "medium bass"

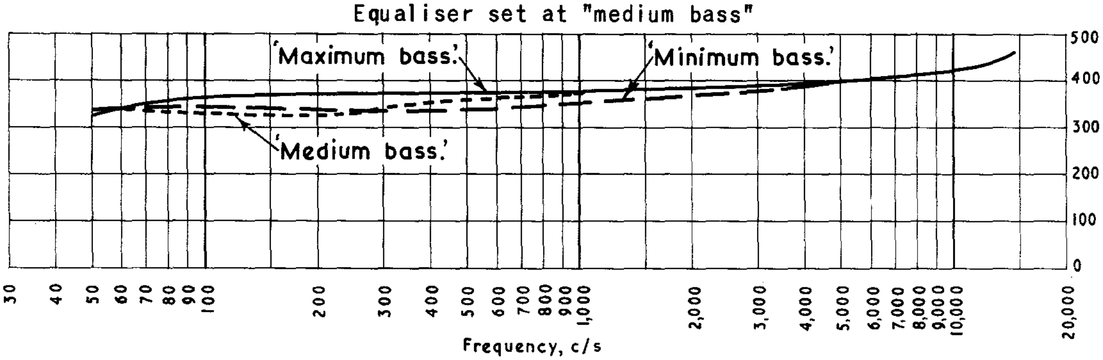

Fig. 11 - Modulus of impedance of prototype L2 microphone
measured at output of equaliser set as shown

The tolerance on impedance is almost entirely determined by that on the ribbon thickness. As the aluminium leaf, from which the ribbon is made, is beaten out by hand, the variation in thickness from sheet to sheet is considerable. As a compromise between various factors, a tolerance of ± 20% is stipulated.

5.3. Transient Response.

The fundamental mode of resonance of the ribbon is so well damped by the acoustic resistances on both sides that the microphone does not ring at this frequency. As is evident from the steady-state frequency response in Fig. 6, the acoustic resistances are too far from the ribbon to suppress completely the higher modes of resonance, but no sign of ringing can be observed by the usual interrupted tone test. The air resonances which cause the rise in response at high frequencies are also well damped and no ringing can be detected.

5.4. Sensitivity.

The open-circuit sensitivity of the average type L2 microphone is −91 dB relative to 1 volt/dyne/cm^2 at 1 kc/s for a plane wave, i.e. 4 dB higher than that of the average type L1, but owing to the different conditions of use this figure is not directly comparable with the sensitivity of other classes of microphone. The corresponding output levels can however be calculated. The theoretical frequency response for normal speech levels is approximately as in Fig. 6(b), from which it will be seen that the sensitivity at 1 kc/s for a point source at $2\frac{1}{8}$ in. is 3 dB higher than that for a plane wave. The sound level at this distance from the mouth is 21 dB higher than at the usual distance of 2 ft (61 cm) from a studio type microphone, so that the effective sensitivity is about 24 dB above the plane-wave figure. The output of an average type L2 microphone may therefore be taken as equal to that of a 300 ohm studio type instrument having an open-circuit sensitivity of −67 dB relative to 1 volt/dyne/cm^2 and used at a distance of 2 ft. For comparison, the corresponding sensitivity of the type AXBT microphone is −71 dB.

5.5. Acoustic Noise.

5.5.1. Ambient Noise.

The ratio of wanted to unwanted signal in the microphone output depends upon several factors. These are, the velocity rise due to proximity of the sound source, the polar response of the microphone, the acoustic screening by the user's head and body and the spectral distribution of the noise.

Assuming that the source of ambient noise produces a plane wave front at the microphone, it may be shown that the ratio of the axial sensitivities to signal and to noise is given by the ratio of the magnitude of the pressure-gradient to the pressure at $2\frac{1}{8}$ in. from a point source, which is shown in Fig. 12 as a function of frequency. The figure-of-eight polar response accounts for an additional 5 dB of suppression at all frequencies to noise at random incidence.

The shielding effect of the user's head and body varies with frequency, and is shown in Fig. 13 as a function of frequency for noise at random incidence. The curve represents the average of measurements taken with six subjects in a reverberation room using one-third octave bands of noise. The probable error varies with

frequency; at 300 c/s, for example, it is $\frac{1}{3}$ dB. The sum total of noise suppression due to all direct effects is shown in Fig. 14.

In estimating the noise suppression obtainable it is usual to take an omnidirectional microphone as the reference standard; however account must be taken of the fact that in practice, an unprotected pressure microphone cannot be used much closer than 6 in. because of breath noises accompanying explosive consonants. If this factor is taken into account, the discrimination of the L2 microphone against ambient noise is 9 dB greater than that shown in Fig. 14.

Subjectively, the degree of noise suppression achieved can be illustrated by the change in signal-to-noise ratio for a commentator speaking in a cheering crowd. With an omnidirectional microphone the commentator's voice is completely drowned, whilst using the lip microphone the pick-up of crowd noise is so reduced that it forms only a soft background to the speech.

5.5.2. Breath Noise.

The two types of breath noise mentioned in section 4.6 cover different frequency ranges.

The unwanted noise due to explosive consonants is mainly composed of low frequencies. It is difficult to obtain an accurate measurement of the suppression of breath noises; the mouth screen reduces the output due to noise, as measured by a P.P.M., by about 10 dB.

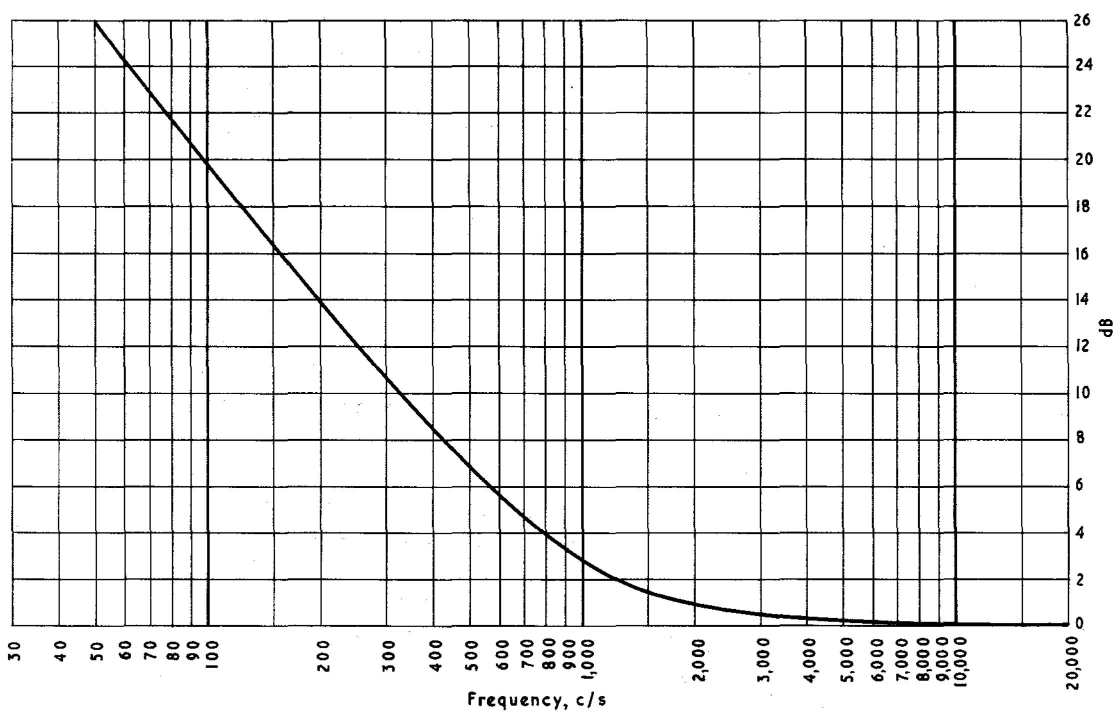

Fig. 12 - Ratio of the magnitude of the pressure gradient to the pressure at $2\frac{1}{8}$ in. from a point source

The noise due to normal breath impinging on the microphone case extends to the higher frequencies. The reduction of this noise output by the screens is also approximately 10 dB.

It should be noted that these figures have been achieved in spite of the reduction in the volume of the type L2 case to one-third of that of the type L1.

5.5.3. Electrical Noise: General.

In the absence of magnetic pick-up, the electrical noise in the microphone is due to the resistive component of the impedance. For the L2 plus equaliser, the open-circuit noise level is −133 dB with reference to 1 volt unweighted and −127 dB when weighted by an aural sensitivity network type ASN/3*. Taking the sensitivity for programme purposes as −67 dB with reference to 1 volt/dyne/cm^2 referred to

*C.C.I.F. Weighting Characteristics for Noise in Music Circuits. (1949)

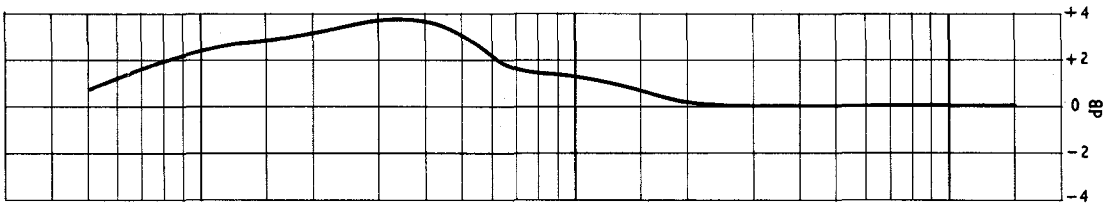

Fig. 13 – Shielding effect of user's head and body for sound at random incidence

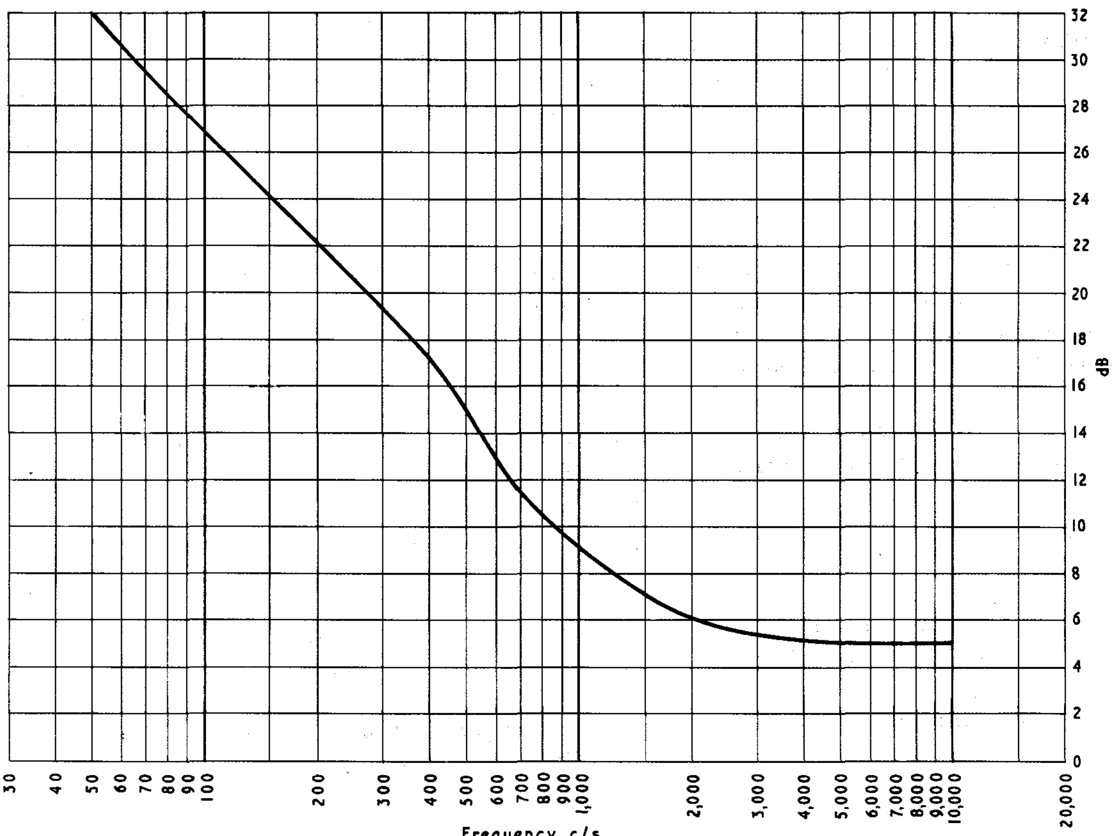

Fig. 14 – Calculated attenuation of ambient noise pick-up in type L2 microphone relative to that of an omnidirectional microphone of equal sensitivity to direct sound

300 ohms, the sound level at 1 kc/s required to give a signal equal to the weighted noise is +14 dB with reference to 2×10^{-4} dyne/cm^2; this is 4 dB lower than that for a typical AXBT microphone.

5.5.4. Electrical Noise: Magnetic Induction.

Although the output of the type L2 is approximately 5 dB higher than that of the type L1, the same limits for magnetic induction have been applied, and it therefore has an even greater signal-to-induction ratio. Since the microphone case is closer to the magnet system than in the type L1 the disturbing effect of eddy currents generated in the case is slightly more pronounced. The specification can however still be met without any difficulty. The maximum magnetic induction in a uniform field was measured on the prototype microphones. The mid-band sound levels, relative to 0·0002 dyne/cm^2, required to give an output equivalent to that produced by a uniform magnetic field of 1 milligauss at 50 c/s, 1 kc/s and 10 kc/s are −10 dB, +8 dB and +24 dB respectively; these figures were obtained by taking the output level computed in paragraph 5.4, and are believed to be the lowest so far obtained in any type of electromagnetic microphone.

6. LISTENING TESTS.

Preliminary listening tests were made in the laboratory and the quality of speech obtained was consistent with that expected from the objective measurements. The signal quality was an improvement on the type L1 particularly at high frequencies. There was a considerable reduction in breath noises from the nose and the mouth and the attenuation of ambient noise was maintained.

7. CONCLUSIONS.

The type L2 microphone has fulfilled the demand for a microphone which is smaller, lighter and more sensitive than its predecessor the type L1. The improvement in frequency response and the increased suppression of breath noises place the microphone in the high-quality class.

The magnetic induction is extremely low, the equivalent sound level being the lowest known for any electromagnetic microphone.

8. REFERENCES.

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